

# Electric Storage Resources in SPP Market - Order 841 Compliance

Yasser Bahbaz

Supervisor Market Forensics

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# FERC ORDER 841

Remove barriers from participation of Electric Storage Resources (ESRs) in markets

Set requirements for participation model but allow RTO/ISO flexibility

Ensure ESRs pay wholesale Locational Marginal Price (LMP) for charging Energy

# FERC ORDER 841 – PARTICIPATION MODEL



Ensure eligibility  
into market if  
technically  
capable

Ensure  
dispatchable  
MSRs can set  
price

Account for  
physical and  
operational  
characteristics  
through bidding

Adopt minimum  
size requirement  
for participation

# TYPES OF ENERGY STORAGE



# ENERGY STORAGE

Demand Side Load  
Management  
(e.g. Fish Freezer)

## Electricity storage

### Mechanical energy

#### Potential energy

- ☐ Pumped hydro
- ☐ Compressed air

#### Kinetic energy

- ☐ Fly wheels

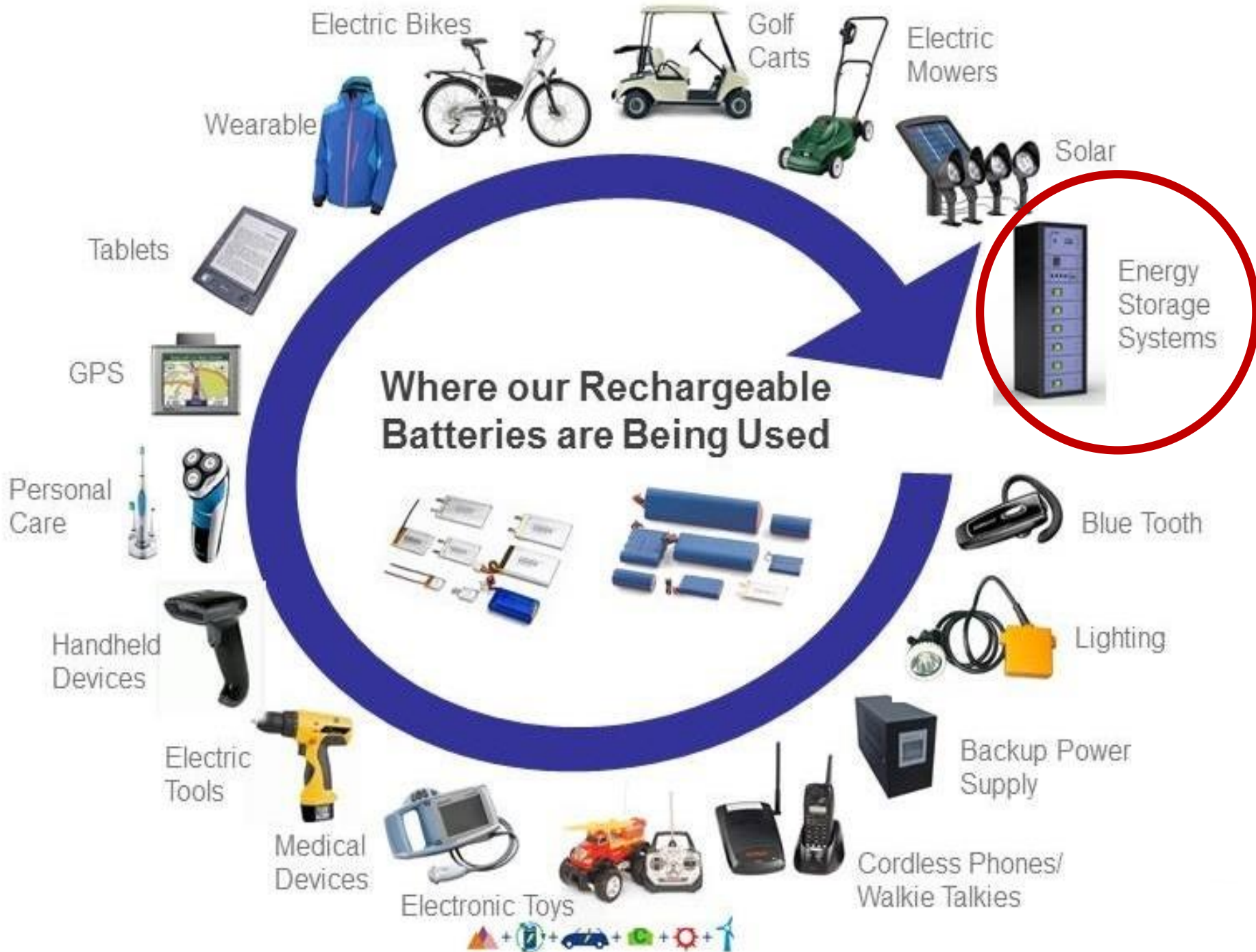
### Chemical energy

- ☐ Batteries
- ☐ Hydrogen
- ☐ Synthetic methane
- ☐ (Fossil energy carriers)
- ☐ (Biomass)

### Electrical energy

- ☐ Capacitors
- ☐ SMES  
(Superconducting  
magnetic  
energy storage)

WHY NOW?

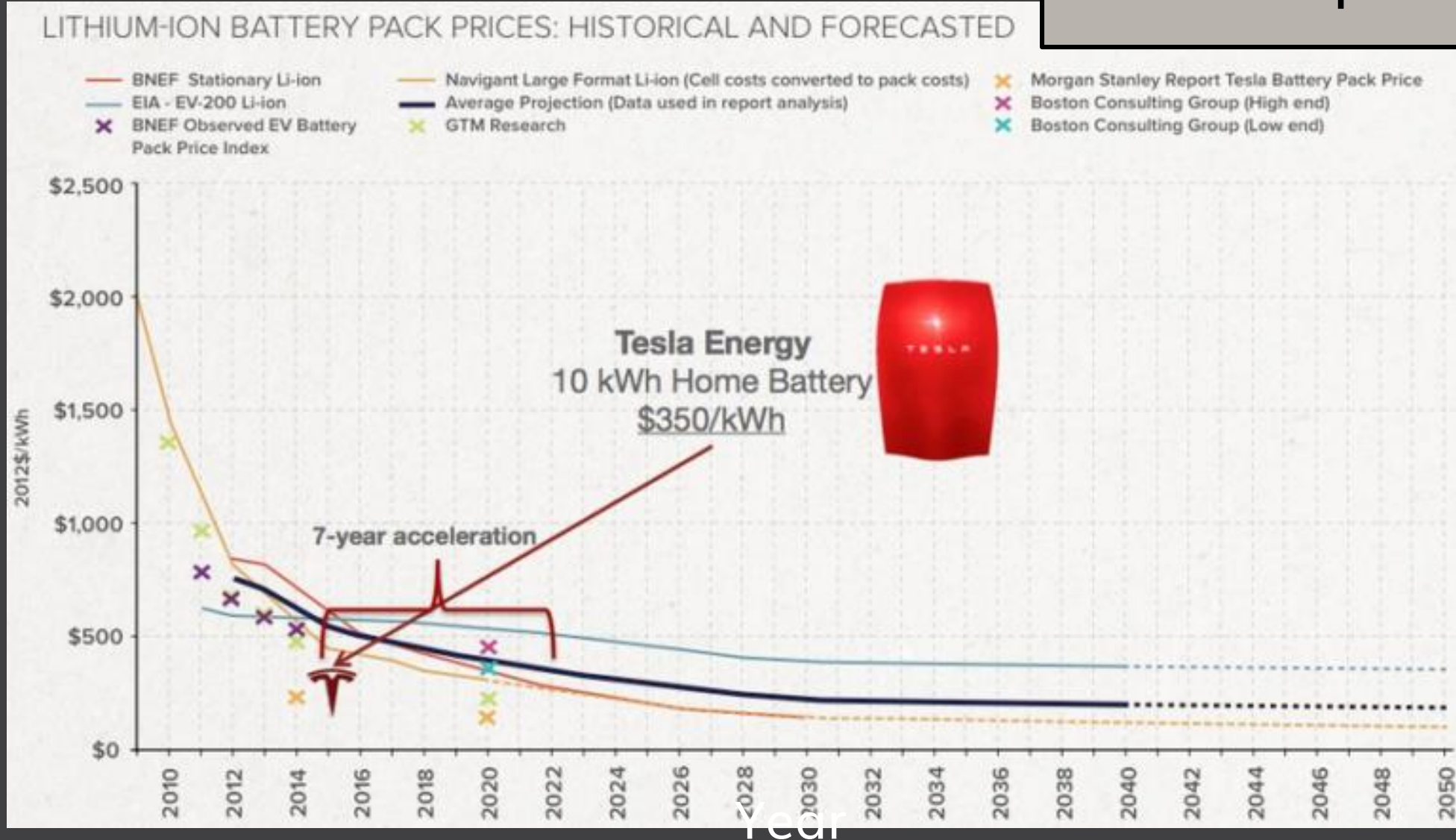


Why  
2018?

# LI-ION PROJECT COST



Most Cost  
Competitive

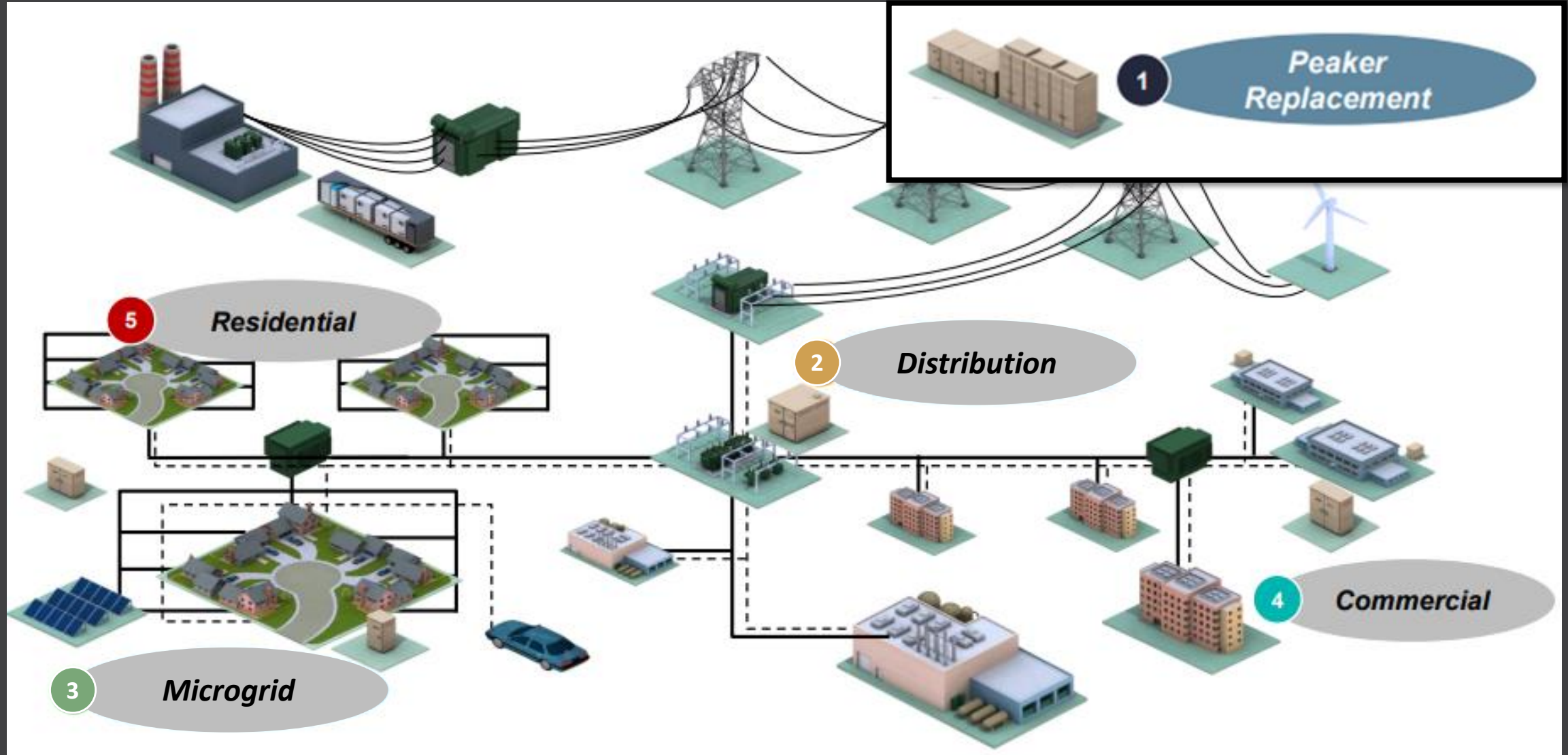
Project Costs (\$/kWh)





# CASE OVERVIEW

 = In-Front-of-the-Meter Use Case  
 = Behind-the-Meter Use Case



# WHY BATTERIES?

Faster Performance

Flexible Operational Bandwidth

Frequency Regulation

Energy Shifting

Clipping LMP Spikes

Reliability of Module Design

Cost Effective

Market Growth (284% in 2016)

# BENEFITS OF BATTERIES



# HOW?

## Market Overview—Applications of Energy Storage in Electricity Value Chain

Electricity Value chain



Applications offered by Energy Storage

- ✓ Electric Energy
- Time Shift
- ✓ Renewable Integration
- ✓ Ancillary services\*

Generation

- ✓ Voltage Support
- ✓ Transmission Congestion Relief
- ✓ T&D Upgrade deferral
- ✓ Sub-station onsite power
- ✓ Micro or Remote Grid

Transmission

Distribution

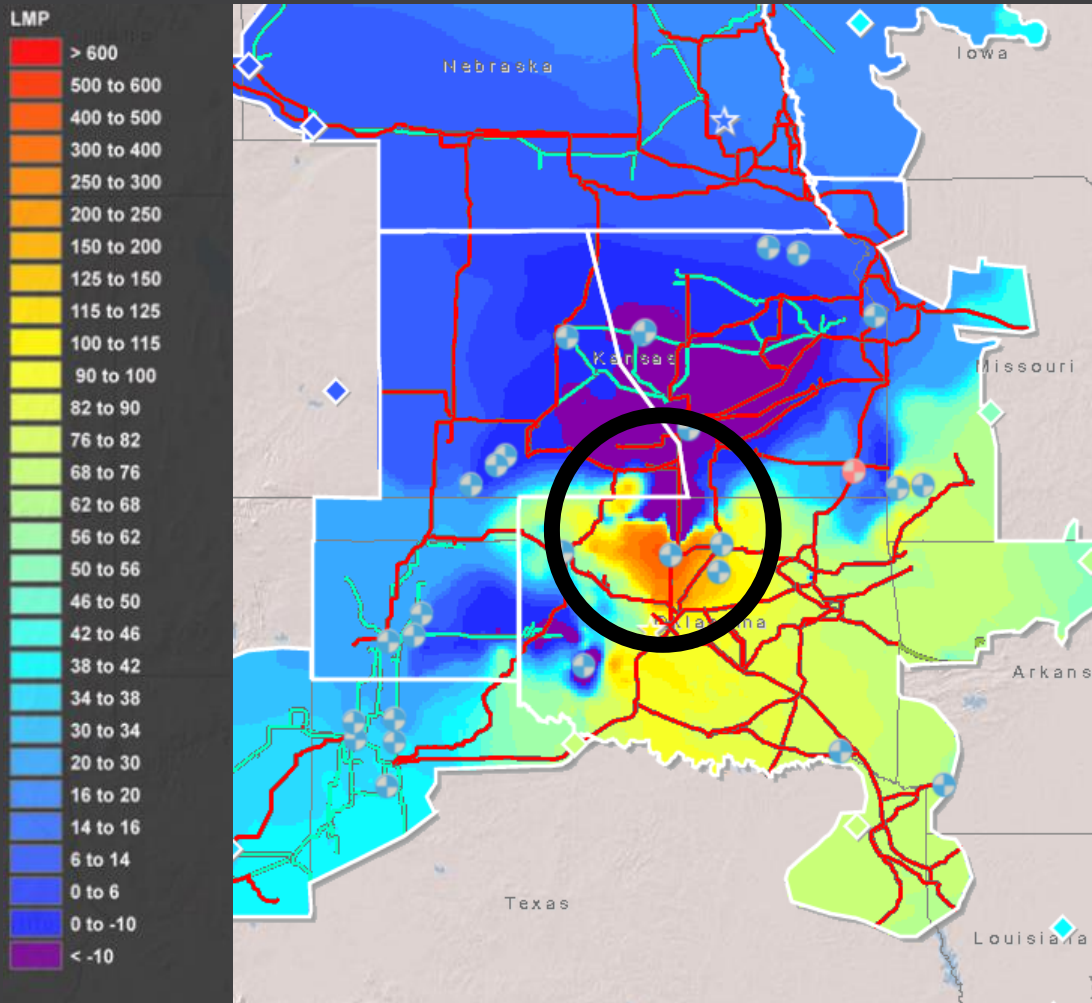
- ✓ Time of use-Energy cost management
- ✓ Power Quality
- ✓ Power Reliability

End-Use applications

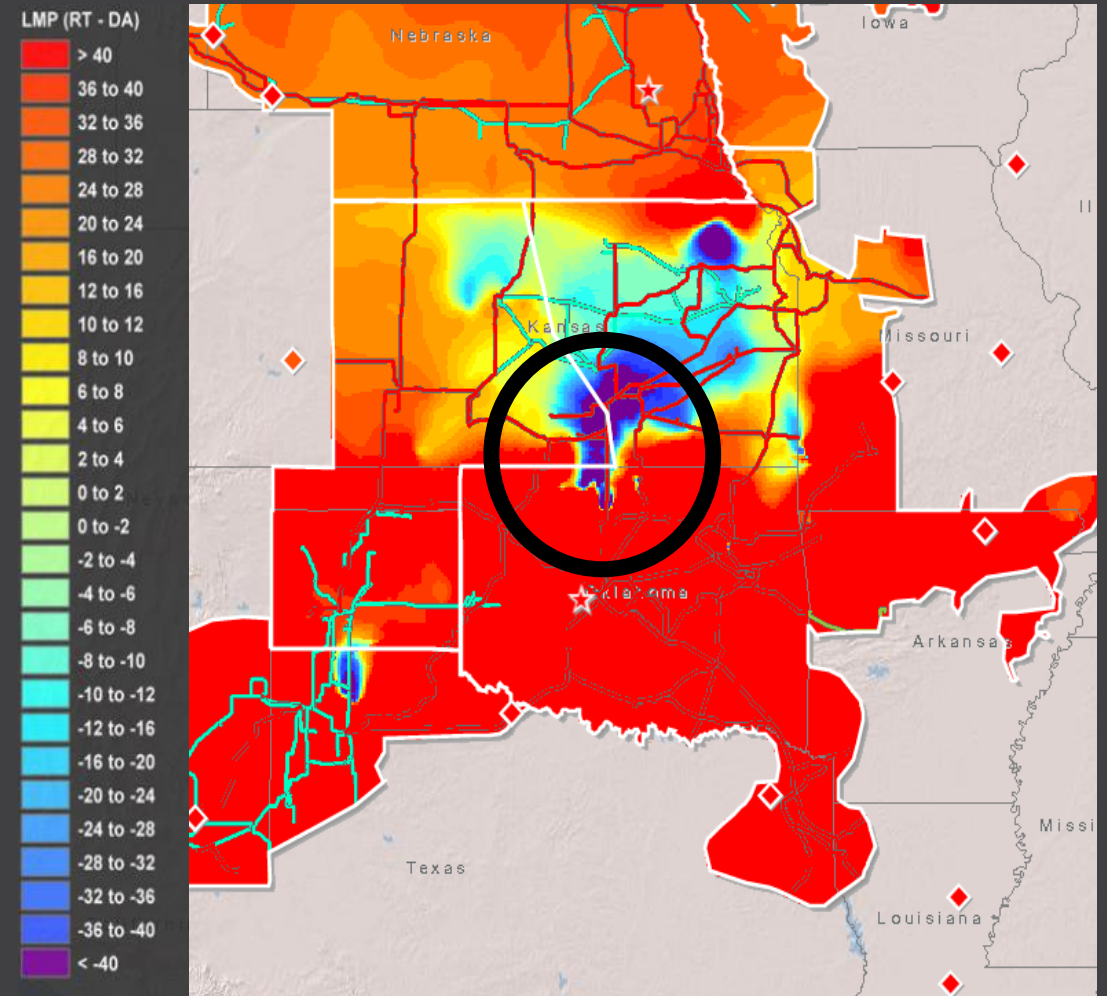


# OPPORTUNITIES FOR BATTERIES

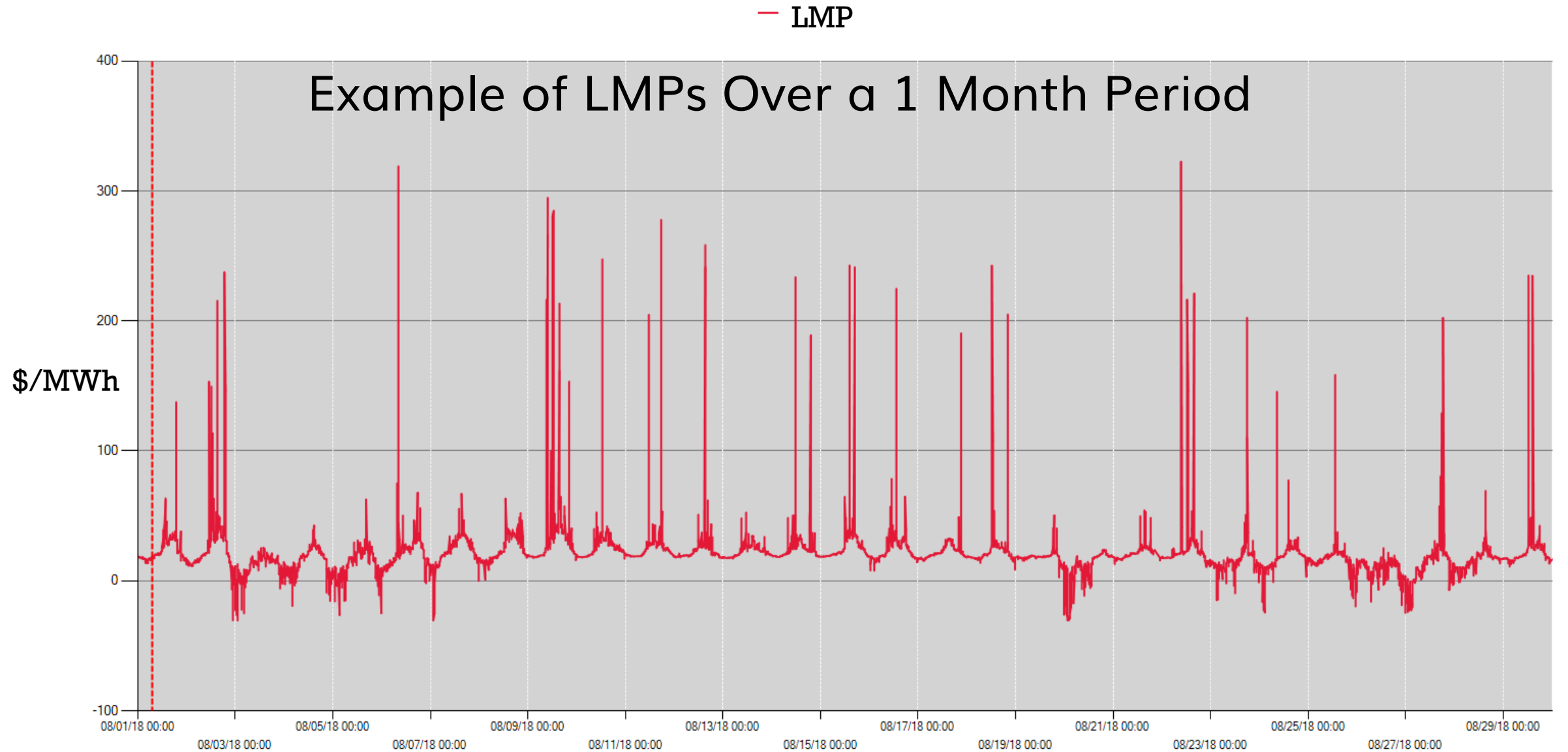
## Real-Time LMP Volatility



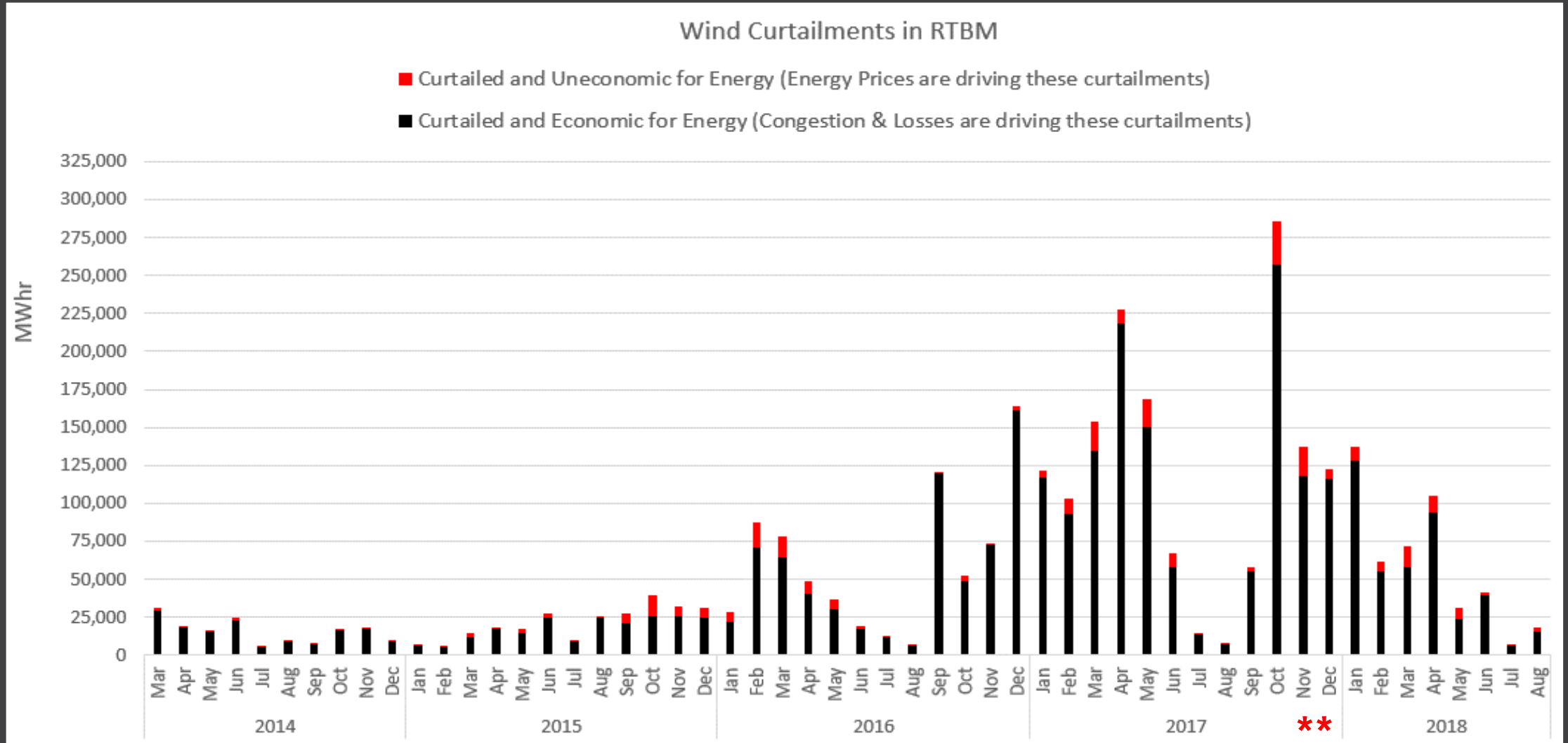
## DA Market Volatility



# LMP Volatility



# WIND CURTAILMENTS BY MONTH



\*\*\* Phase Shifter and two 345kV lines added in 2017 that are now alleviating wind curtailments in Western Oklahoma

# SPP AND ENERGY STORAGE





How many Electric Storage Resources does SPP have in its footprint?

# SPP' S SYSTEM

South Dakota

Wyoming

Nebraska

Iowa

Two (20 MW)  
battery projects

Several Battery/  
Solar Applications

Kansas

Missouri

1 Pumped Storage Facility



New Mexico

Oklahoma



# Distribution of Generation

**SPP** Southwest  
Power Pool

## Generation Mix



## Capacity (MW)



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Date Exported 8/3/2018 1 inch equals 182 miles

# WHAT DOES THE FUTURE LOOK LIKE?



More requests  
in GI Queue



Solar and  
Battery Pairing



Wind and  
Battery Pairing



Freq. Reg. and  
Energy Shifting



Decreased  
Battery Prices



Increasing  
Growth



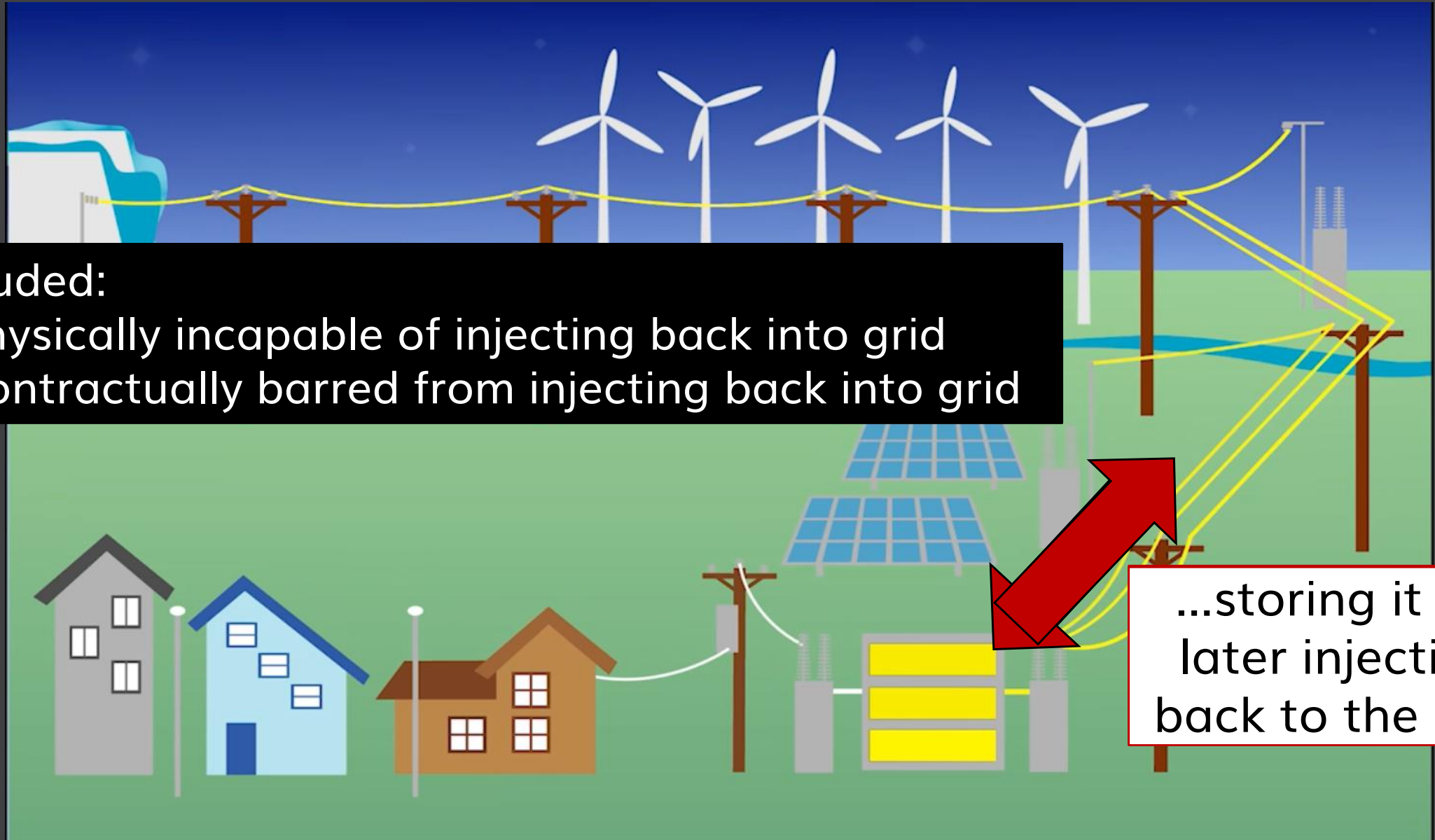
# MARKET DESIGN OVERVIEW

Market Storage Resource (MSR)

# MARKET STORAGE RESOURCE (MSR)

Excluded:

1. Physically incapable of injecting back into grid
2. Contractually barred from injecting back into grid



# MSR PARTICIPATION

Do ESRs have to participate  
in the MSR model?

- Only used by ESRs but not mandatory
- May continue to use Gen and Load pair



# UNIQUE OFFER PARAMETERS

State of Charge

Min/Max Charge Time

Min/Max State of Charge

Min/Max Discharge Time

Min/Max Charge Limit

Up Ramp Rate

Min/Max Discharge Limit

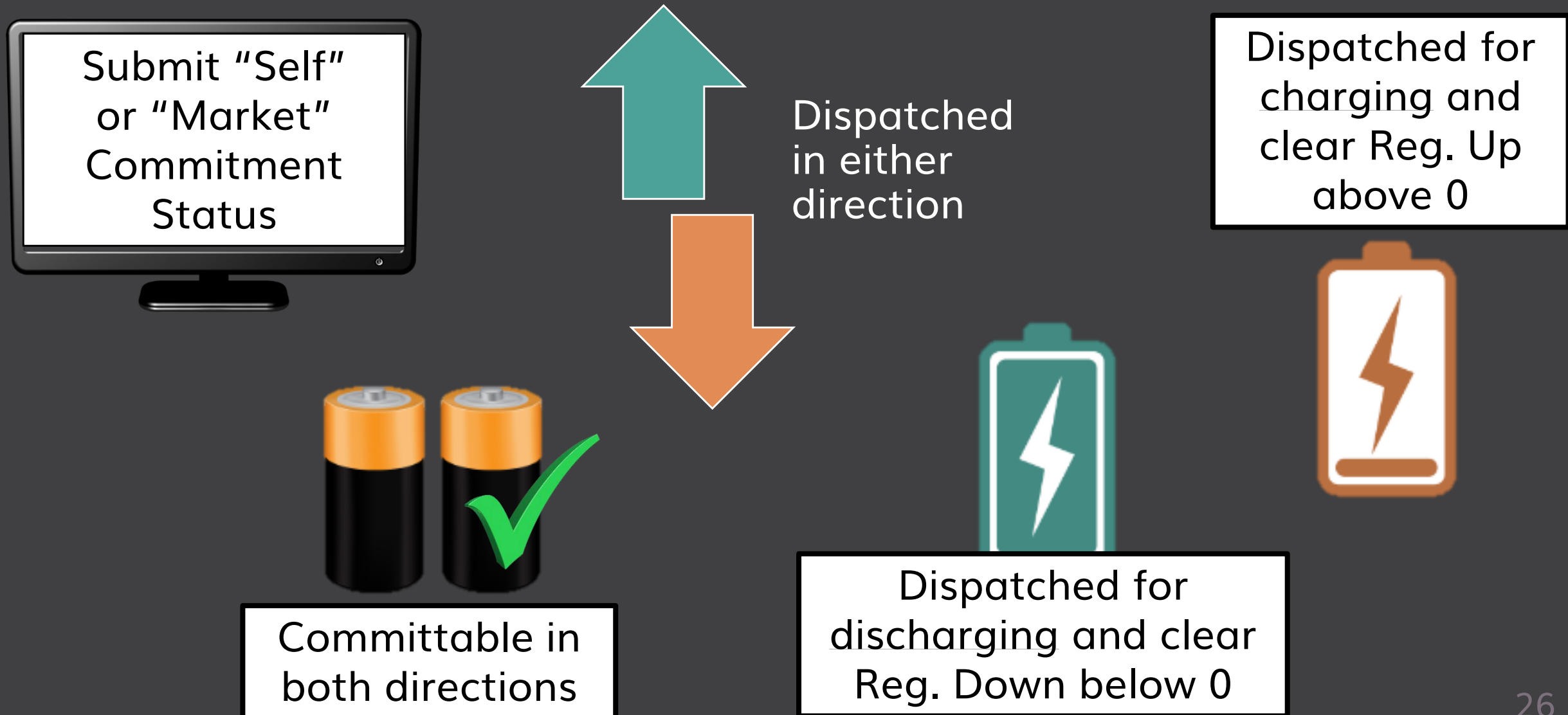
Down Ramp Rate



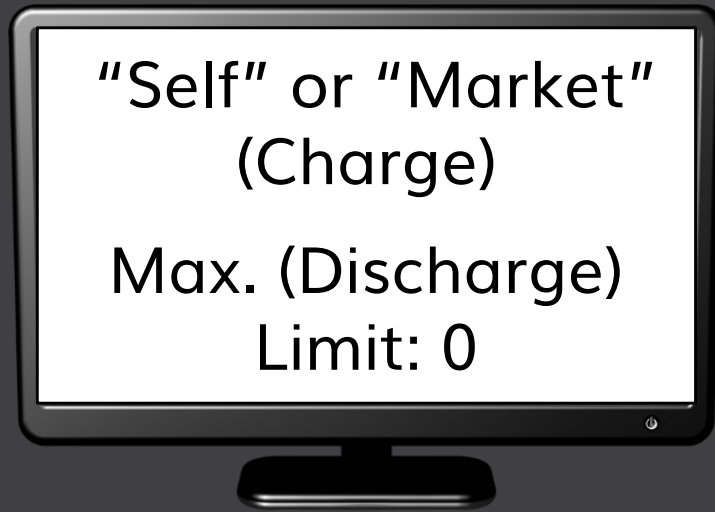
# TWO MARKET COMMITMENT PATHS



# PATH 1 – MSRs WITH ZERO LIMIT / TIME



# PATH 2 – ALL OTHER MSR<sub>s</sub>



- Specify commit direction with "Self" or "Market"
- Zeroing out Max Charge/Discharge Limit in opposite direction



Only committed and dispatched in direction offered



Dispatched and clear Operating Reserve within range of offered direction

# STATE OF CHARGE (SOC)

To Self-Manage SOC:

- “Self” into Market
- Specify self dispatch range through Max and Min limit

Considerations:

- Self schedule needs to be communicated to SPP through normal RUC process
- If in Self-Managed SOC not directed by SPP, transmission charges will apply





# SETTLEMENTS

## Locational Marginal Price (LMP)

- Settled on LMP for Energy withdrawal/injection

## Market Clearing Price (MCP)

- Settled on MCP for Operating Reserve products cleared

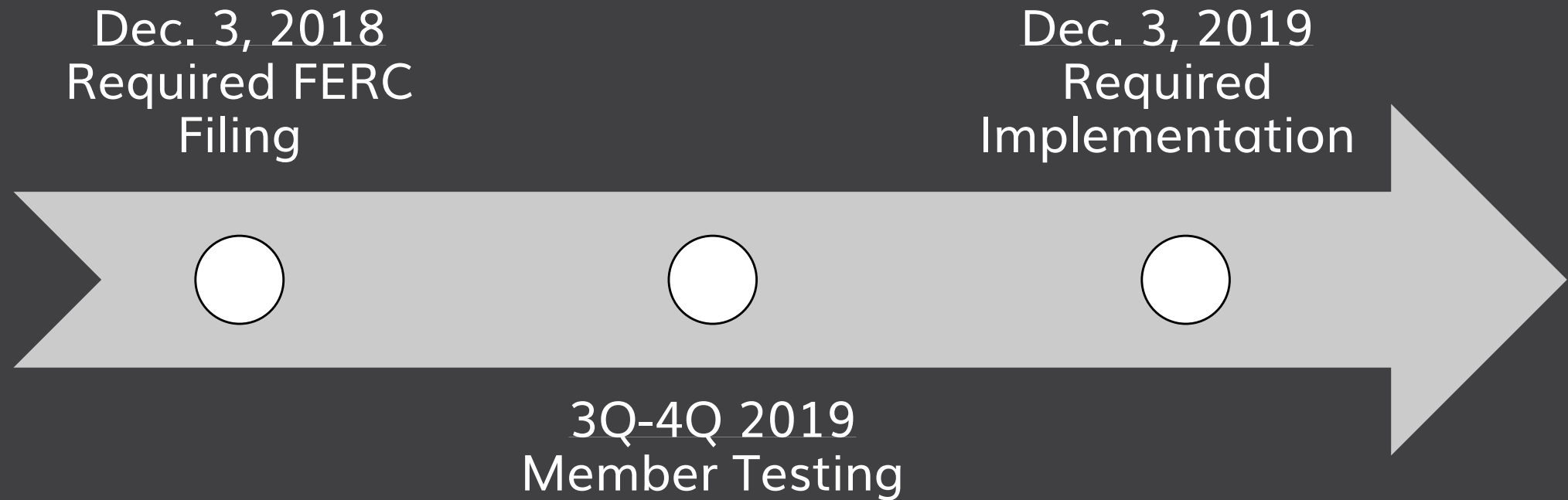
## Negative Generation

- Settlements calculations are updated in the Revision Request for negative generation

## Metering

- Each MSR must have its own set up

# TIMELINE





**WHAT QUESTIONS  
DO YOU HAVE?**